Obesity Research & Clinical Practice (2014) 8, e266—e270

Relationship between estimated fatty acid desaturase activities and abdominal adiposity in Japanese children

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Received 12 December 2012; received in revised form 12 March 2013; accepted 12 March 2013

KEYWORDS
Delta 6 desaturase;
Delta 5 desaturase;
Stearoyl-CoA desaturase;
Waist to height ratio;
Children

Summary
Background: Abdominal obesity alters the composition of plasma and tissue long chain fatty acids and thus affects a number of important physiological functions relating to the development of cardiometabolic diseases. The fatty acid composition is modulated by desaturases; stearoyl-CoA desaturase (SCD), delta-6 desaturase (D6D) and delta-5 desaturase (D5D). Therefore, we examined the relationship between the desaturase activities and abdominal adiposity.
Methods: One hundred eighty-one children (98 males, 83 females), including 42 children with abdominal obesity having waist to height ratio (WHtR) >0.5, were recruited. Fatty acid composition in plasma phospholipids was analyzed by gas chromatography after overnight fast, and SCD activity was estimated by 18:1/18:0 ratio.
Results: In children without abdominal obesity, WHtR correlated positively with D6D activity ($r = 0.252$, $p = 0.0027$) and negatively with SCD activity ($r = -0.289$, $p = 0.0006$), but not with D5D activity ($r = -0.159$, $p = 0.0607$). While in children with abdominal obesity, WHtR had a positive association with SCD activity ($r = 0.332$, $p = 0.0315$), but not with D6D ($r = 0.267$, $p = 0.0847$) or D5D activity ($r = 0.008$, $p = 0.9600$).
Conclusion: The relationship between the desaturase activities and abdominal adiposity altered in children with abdominal obesity. Especially, SCD activity demonstrated a U-shaped association with WHtR.

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1871-403X/$ — see front matter
http://dx.doi.org/10.1016/j.orcp.2013.03.001

Introduction

Previous studies have confirmed that abdominal adiposity is associated with cardiometabolic risks [1,2], even in children [3]. Abdominal obesity alters the composition of plasma and tissue long chain fatty acids and thus affects a number of important physiological functions relating to the development of cardiometabolic diseases [4].

In humans, three fatty acid desaturases are known; stearoyl-CoA desaturase (SCD), delta-6 desaturase (D6D) and delta-5 desaturase (D5D). SCD is the rate-limiting enzyme in the biosynthesis of monounsaturated fatty acids (MUFAs), and D5D and D6D are key enzymes in polyunsaturated fatty acid (PUFA) metabolism [5]. Therefore, these desaturases play an important role to modulate fatty acid composition. In human studies, the estimated desaturase activities, which are obtained by the product/substrate ratio for each enzyme, have been investigated, demonstrating that increased SCD and D6D activities and a decreased D5D activity are closely associated with cardiometabolic risks [6—9]. However, the information about desaturase activity in children is limited [10—13].

In the present study, we investigated the relationship between the desaturase activities and abdominal adiposity in Japanese children. Additionally, the impact of leptin level on the SCD activity was also elucidated, because leptin is one of the hormonal regulators of SCD activity [14].

Subjects and methods

The study subjects were 181 children (98 male, 83 female) aged 11.0 ± 1.7 years (mean ± SD), who were recruited from a school-based screening and care program for life-style related diseases and our out-patient clinic. All children were free from diseases other than dyslipidemia and obesity. Standing height and body weight were measured, and percentage of overweight (POW) was calculated as (actual body weight − standard weight)/standard weight × 100 (%)), according to the standard weight obtained for sex, age and height. Obesity was defined as having POW > 20% [15]. The waist circumference was measured at the level of the umbilicus, and the waist to height ratio (WHtR) was obtained. The definition of abdominal obesity was WHtR over than 0.5 [16,17]. Blood samples were collected after overnight fasting. Serum leptin level was determined using a human leptin radioimmunoassay kit (LINCO Research, Inc.). Fatty acid composition in plasma phospholipids was analyzed by gas chromatography, and the desaturase activities were estimated as follows: SCD (18:1/18:0), D6D (20:3n-6/18:2n-6) and D5D (20:4n-6/20:3n-6). Informed consent was obtained from each child and his or her parents, and the study protocol was approved by the University Ethics Committee (Nihon University, Itabashi Hospital).

Statistical analysis

All data were expressed as mean ± SD. Group differences were assessed using the unpaired Student-*t* test. Serum leptin levels were transformed into natural logarithmic values because of a skewed distribution. The correlation coefficients between two variables were determined by single regression analysis. A *p*-value less than 0.05 was considered to indicate statistical significance. All statistical analyses were conducted using the statistical package JMP (v9.0; SAS Institute Inc., Cary, NC, USA).

Results

The characteristics of the study population were shown in Table 1. Females had higher leptin level than males in both children with and without abdominal obesity. SCD and D5D activities were lower and D6D activity was higher in children with abdominal obesity than children without abdominal obesity in both sexes. Females had lower D6D activity than males, however no other sex difference was demonstrated.

The relationships between the desaturase activities and WHtR were investigated. In total subjects combined, WHtR had a positive association with D6D activity ($r = 0.576$, $p < 0.0001$) and negative associations with D5D ($r = -421$, $p < 0.0001$) and SCD activities ($r = -0.230$, $p = 0.0018$).

Next, we investigated the relationships in 2 divided groups; children with abdominal obesity and children without abdominal obesity (Fig. 1). In children without abdominal obesity, WHtR correlated positively with D6D activity ($r = 0.252$, $p = 0.0027$) and negatively with SCD activity ($r = -0.289$, $p = 0.0006$), but not with D5D activity ($r = -0.159$, $p = 0.0607$). While in children with abdominal obesity, WHtR had a positive association with SCD activity ($r = 0.332$, $p = 0.0315$), but not with D6D ($r = 0.267$, $p = 0.0847$) or D5D activity ($r = 0.008$, $p = 0.9600$).

Log leptin correlated positively with WHtR ($r = 0.774$, $p < 0.0001$) in the total subjects. In addition, SCD activity correlated negatively with